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Yasuno et al.

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(54) **MANUFACTURING METHOD OF AIR PASSAGE SWITCHING DOOR**

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(52) **U.S. Cl.** **264/274**; 264/259; 264/275; 264/279.1; 264/328.8; 264/328.12
(58) **Field of Search** 264/274, 259, 264/275, 279.1, 328.8, 328.12

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(57) **ABSTRACT**

An air passage switching system includes a switching door that is disposed rotatably in a case to open and close an air passage of the case. The switching door includes a door body, a rotation shaft provided in the door body, and a seal member made of an elastomer and adhering to an outer peripheral portion of the door body. The seal member contacts on a sealing surface of the case when the switching door closes the air passage. A plurality of recess portions are formed on the outer peripheral portion of the door body to be arranged in an outer peripheral direction. Thus, adhesion between the door body and the seal member can be strengthened.

8 Claims, 4 Drawing Sheets

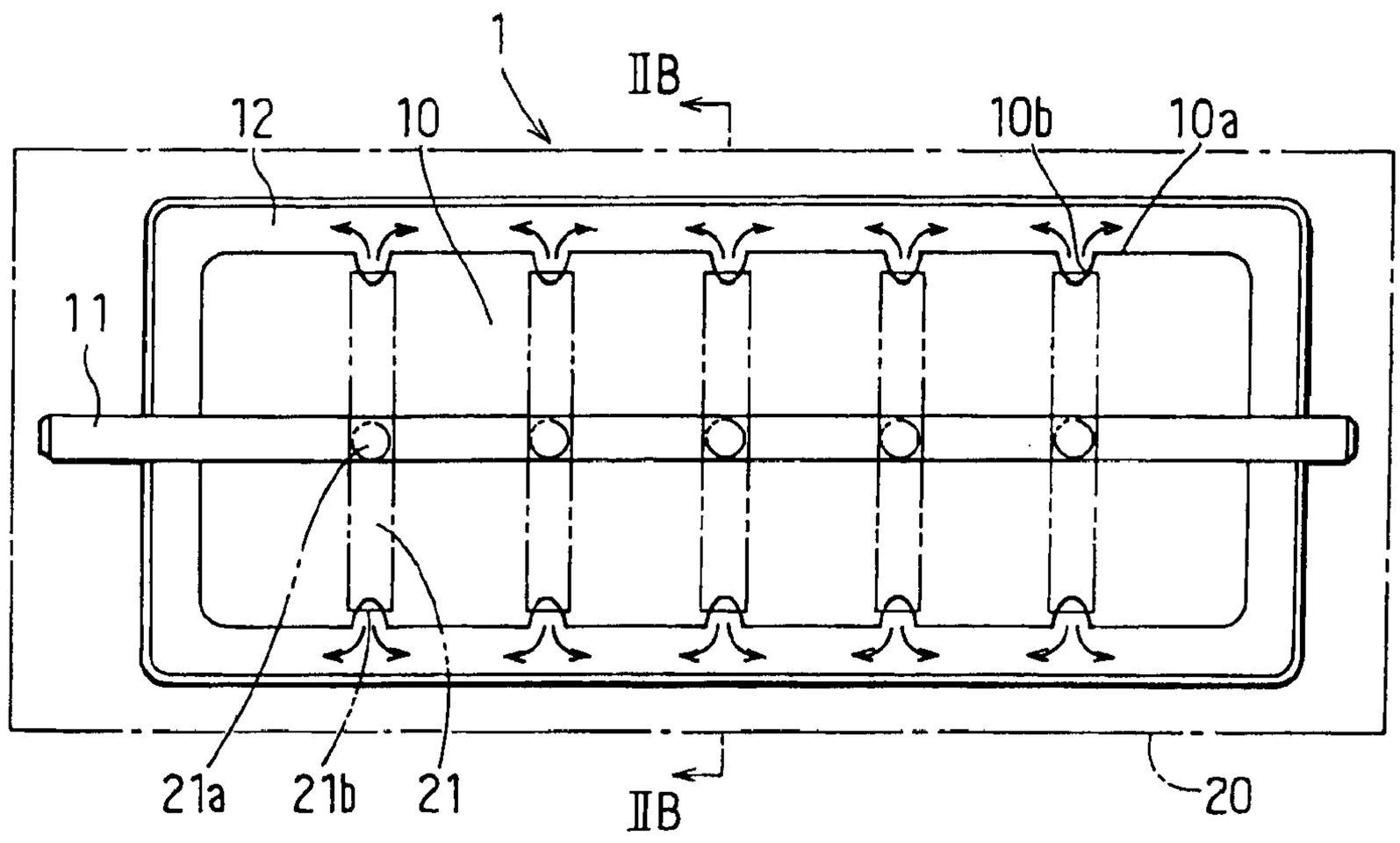


FIG. 1

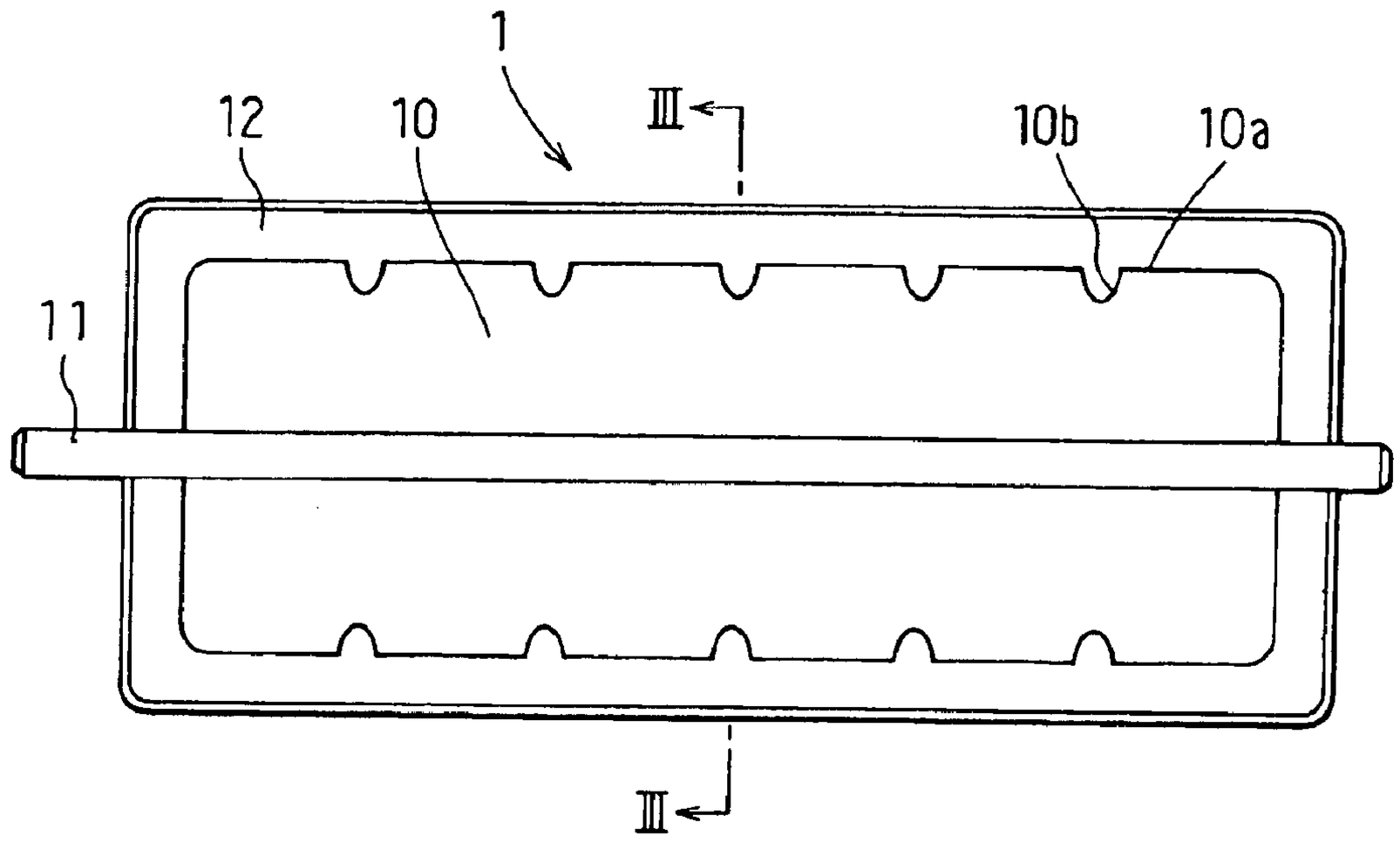

1
12
10
III
10b
10a
11
III

FIG. 3

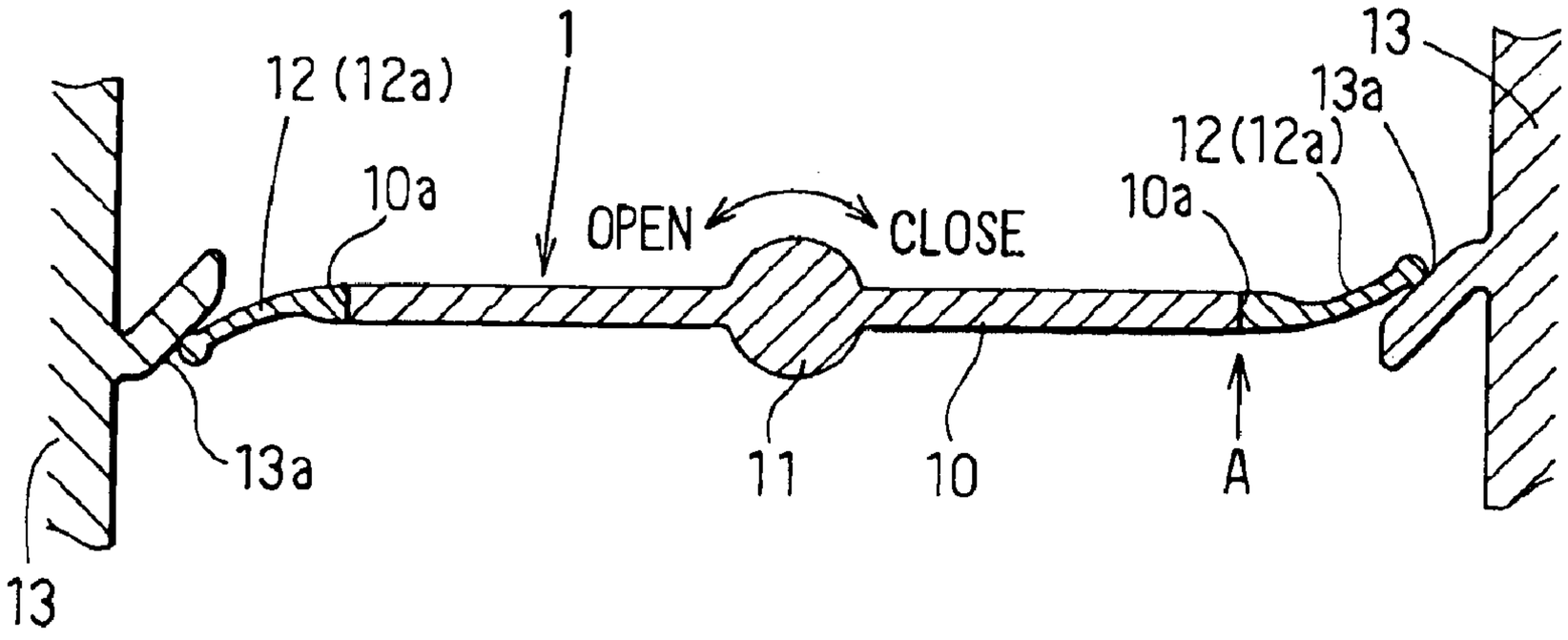

1
12 (12a)
10a
OPEN
CLOSE
13
13a
12(12a)
10a
13a
13
11
10
A

FIG. 2A

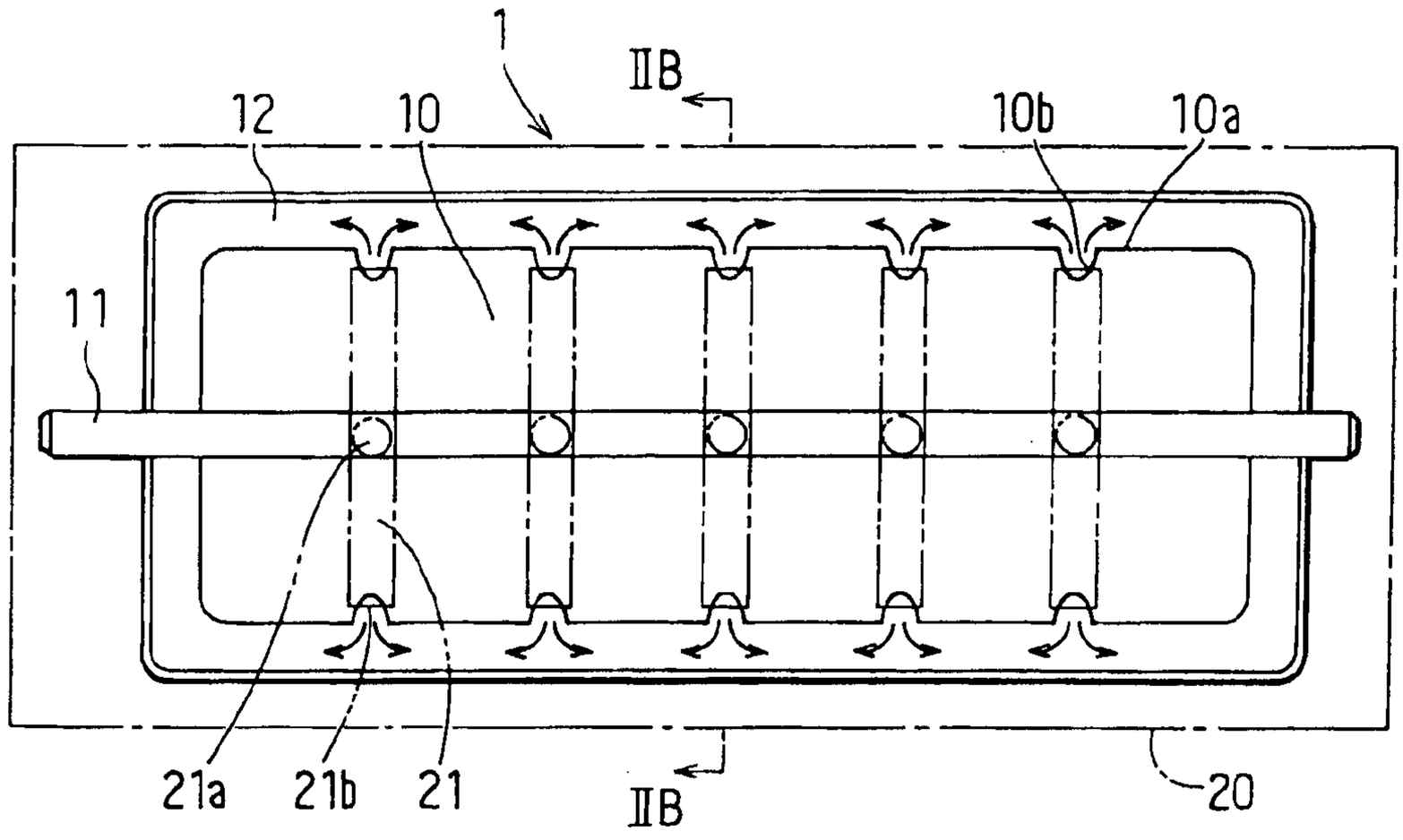

1
IIB
12
10
10b
10a
11
21a
21b
21
IIB
20

FIG. 2B

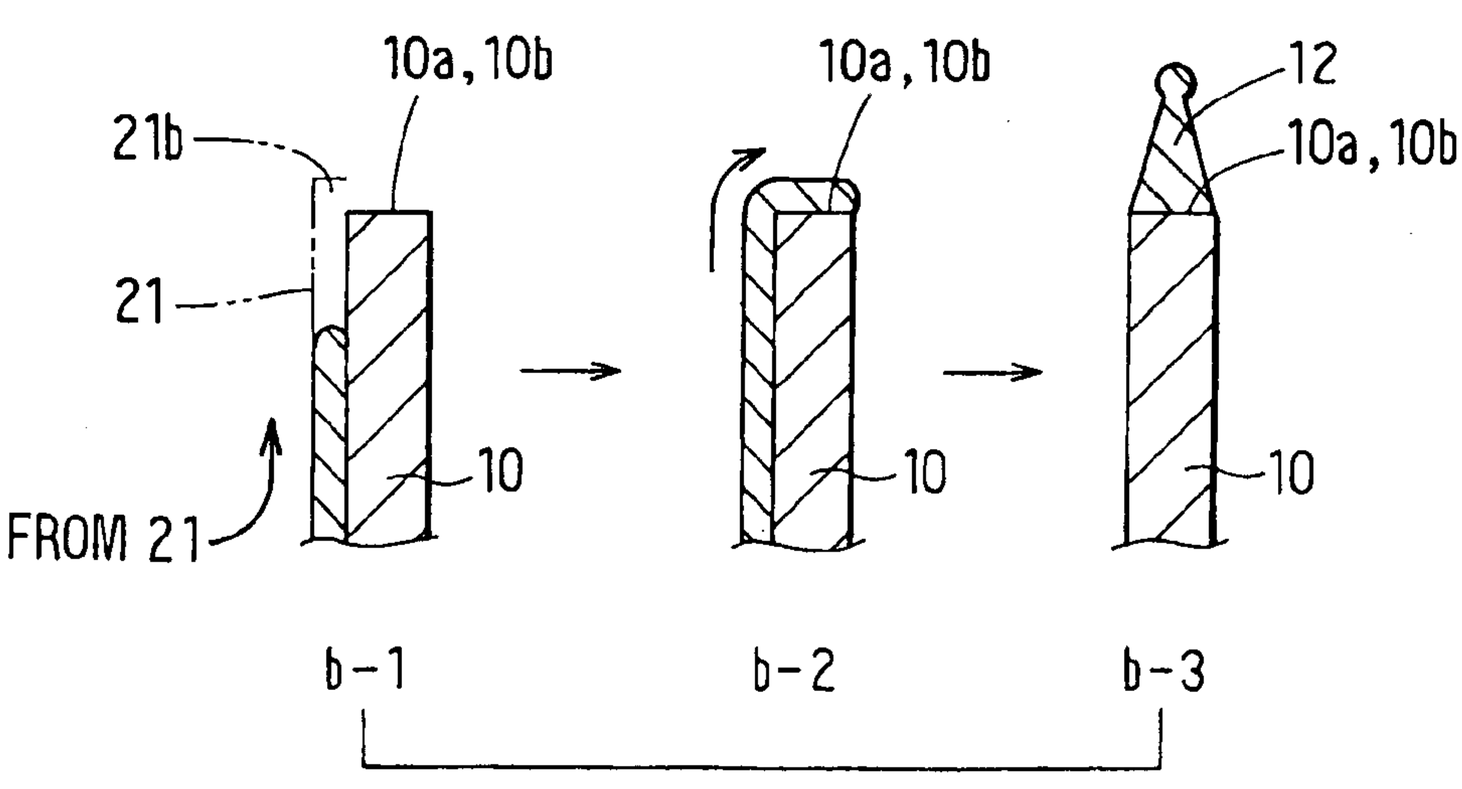

10a, 10b
10a, 10b
12
10a, 10b
21b
21
FROM 21
10
10
10
b-1
b-2
b-3

FIG. 4

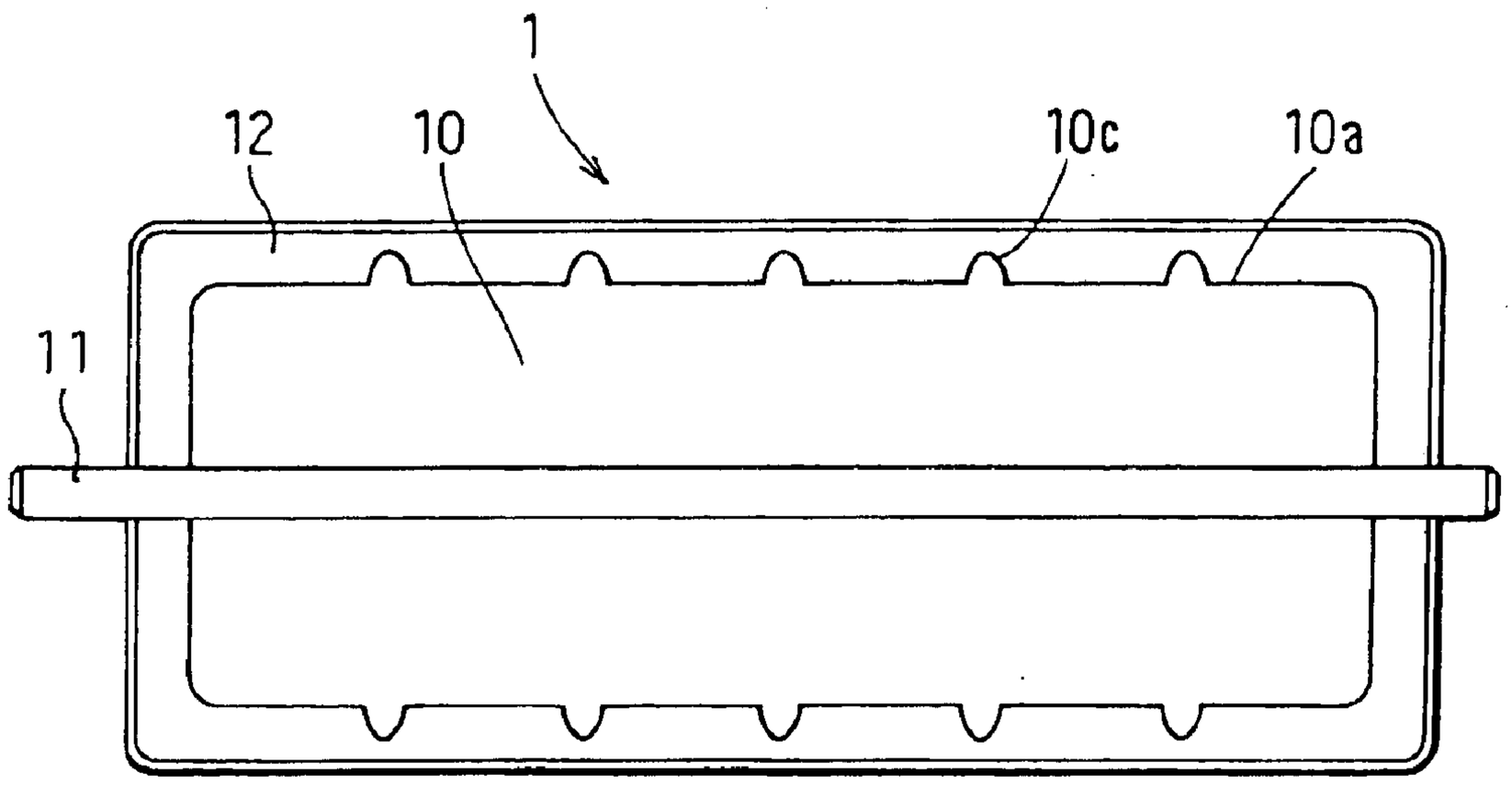


FIG. 5

FIG. 6

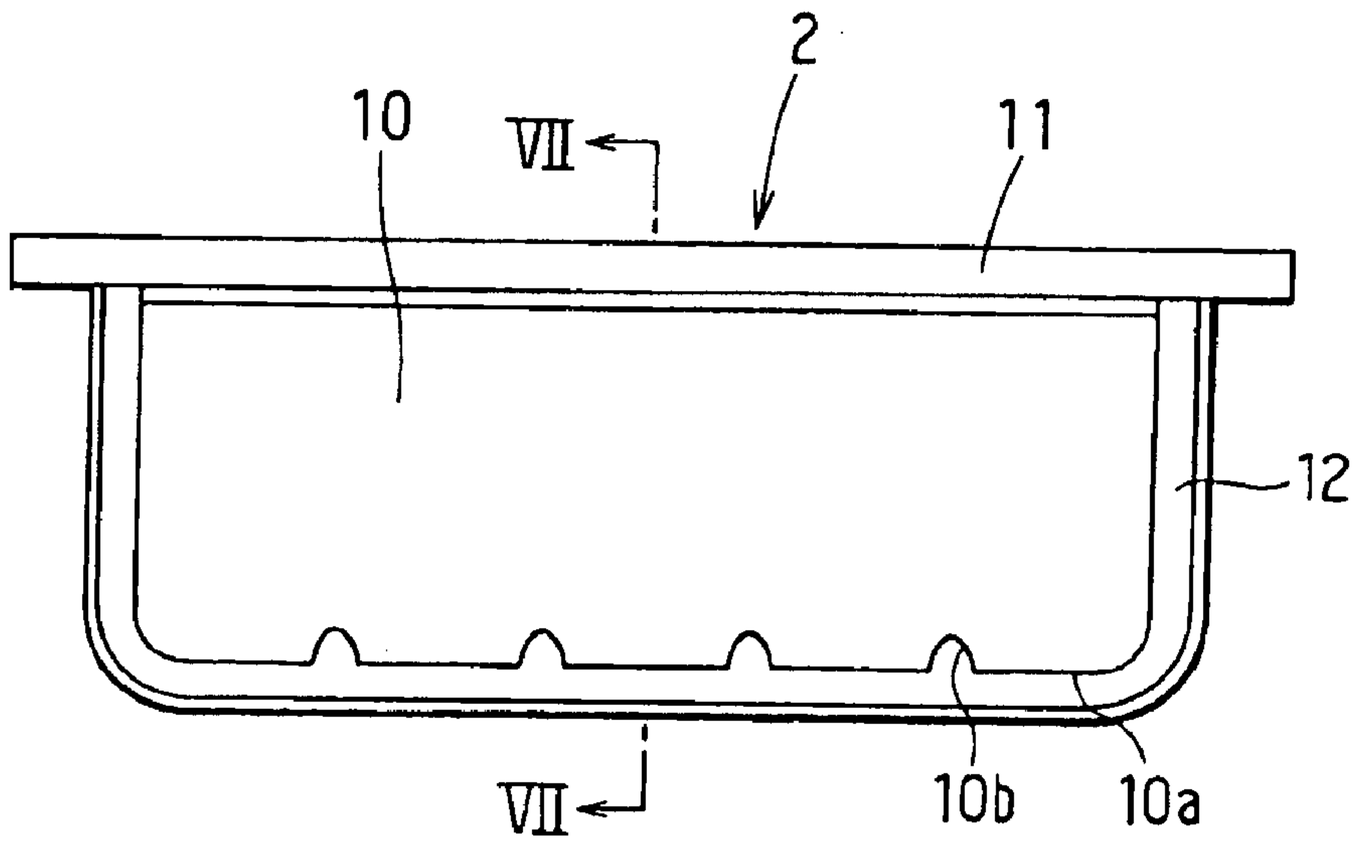
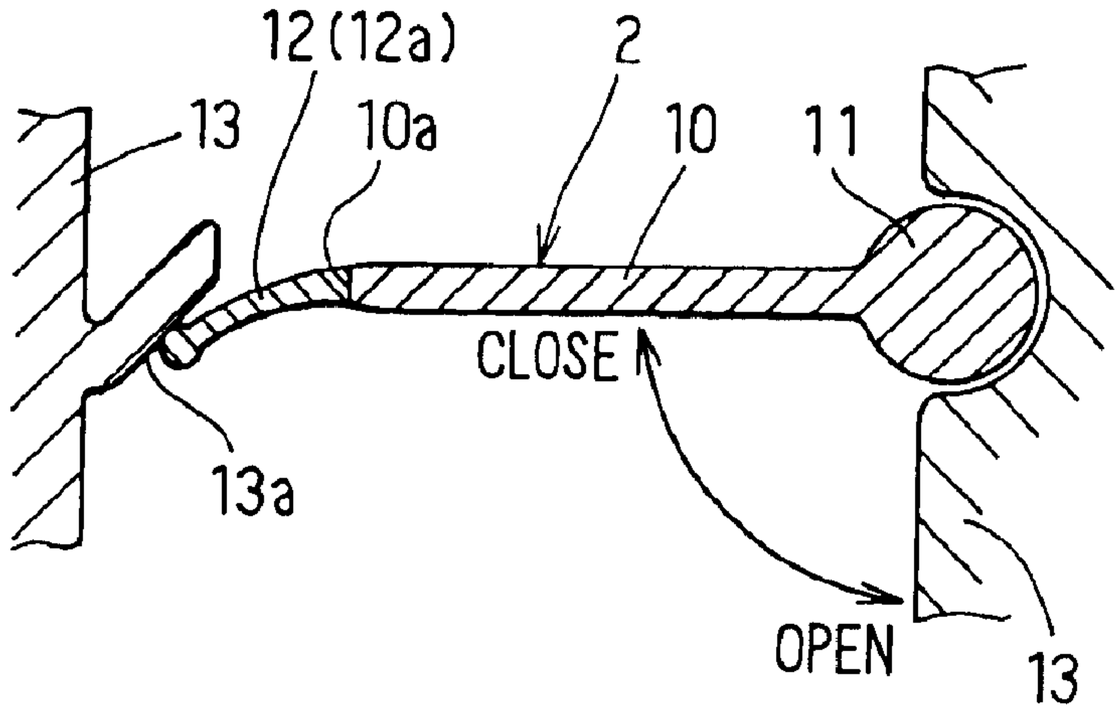


FIG. 7



MANUFACTURING METHOD OF AIR PASSAGE SWITCHING DOOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is based on and incorporates herein by reference Japanese Patent Application No. 2002-239246 filed on Aug. 20, 2002.

FIELD OF THE INVENTION

The present invention relates to an air passage switching system having a switching door for opening and closing an air passage through which air flows, and a manufacturing method of the switching door. More particularly, the present invention relates to a structure of adhesion between a door body and a seal member that is press-fitted onto a sealing surface of a case having the air passage.

BACKGROUND OF THE INVENTION

In a conventional air passage switching door for an air conditioner described in U.S. Pat. No. 6,047,951 (corresponding to JP-A-11-180129), a seal member that is made of an elastomer, a rubber or the like, is provided on an outer peripheral portion of a door body, and is press-fitted to a sealing surface of a case having an air passage in order to switch the air passage. In the air passage switching door, the door body is made of resin to have a high rigidity (i.e., inelastic property). Further, a rotation shaft is formed integrally with the door body at a center in a lateral direction. Generally, the seal member made of a rubber material is inserted into a mold at a preset position in the mold, and thereafter a resin material is injected into the mold, so that the outer peripheral portion of the door body is connected to the seal member.

However, when the seal member press-contacts the seal surface for closing the air passage, peeling force (i.e., separation force) works to the outer peripheral portion of the door body. Adhesion strength is required between the seal member and the door body at the outer peripheral portion, so that the outer peripheral portion of the door body is not separated from the seal member due to the peering force working on the outer peripheral portion in a shearing direction (see "A" direction in FIG. **3**). Thus, when the adhesion strength is low, the seal member is separated from the door body.

SUMMARY OF THE INVENTION

In view of foregoing problems, it is an object of the present invention to provide an air passage switching system having a switching door in which adhesion is strengthened between an outer peripheral portion of a door body and a seal member. It is another object of the present invention to provide a manufacturing method of the air passage switching door.

According to a first aspect of the present invention, an air passage switching system includes a case forming an air passage, and a switching door disposed rotatably in the case to switch an air flow of the air passage. The switching door includes a door body, a rotation shaft on the door body, and a seal member made of an elastomer. The seal member adheres to an outer peripheral portion of the door body, and the seal member press-contacts a sealing surface of the case when the door closes the air passage. In the air passage switching door, at least one of a recess portion and a protrusion portion is provided in the door body on the outer peripheral portion. Accordingly, adhesion area between the door body and the seal member is widened. Thus, adhesion between the door body and the seal member is strengthened comparing with a conventional structure which doesn't have the recessed portion or the protrusions. As a result, the door body and the seal member can have stable adhesion strength by injection molding. In the present invention, plural recess portions or plural protrusion portions can be provided on the outer peripheral portion of the door body. In this case, the adhesion strength between the door body and the seal member can be further increased.

According to a second aspect of the present invention, in a manufacturing method of an air passage switching door, after a door body having a plurality of recess portions recessed from an outer peripheral portion is formed, the door body is inserted in a mold, at a predetermined position, such that the recess portions are positioned to approximately correspond to outlets of runners for supplying an injection material in the mold. Further the outlets of the runners are throttled to increase a flow speed of the injection material and to increase a temperature of the injection material around the recess portions. Accordingly, the adhesion strength between the door body and a seal member made of the injection material can be effectively improved.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. **1** is a front view illustrating a butterfly door according to a first preferred embodiment of the present invention;

FIG. **2**A is a schematic diagram for explaining an injection of a rubber material in a molding of a seal member of the butterfly door, and FIG. **2**B is a schematic diagram showing a flow of the rubber material in the molding, according to the first embodiment;

FIG. **3** is a cross-sectional view illustrating the butterfly door taken along the line III—III in FIG. **1**;

FIG. **4** is a front view illustrating a butterfly door according to a second preferred embodiment of the present invention;

FIG. **5** is a front view illustrating a butterfly door according to a third preferred embodiment of the present invention;

FIG. **6** is a front view illustrating a switching door according to a modification of the present invention; and

FIG. **7** is a cross-sectional view taken along the line VII—VII in FIG. **6**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A first embodiment of an air passage switching system according to the present invention will be described with referent to FIG. **1** to FIG. **3**. In the first embodiment, an air passage switching system having a switching door is typically used for an air conditioner for a vehicle. For example, the switching door is used as a mode door that switches an air flow toward a face opening, a defroster opening and a foot opening, or is used as an air mixture door that adjusts an air outlet temperature by controlling ratio of cool air to warm air.

As shown in FIG. **1**, the air switching system includes a butterfly door **1** as the switching door having a door body **10** which is rectangular shaped. In the switching door, the door

body **10** is made of a resin material to construct a high rigid portion, in other words, an inelastic part. A rotation shaft **11** is formed integrally with the door body **10** at a center in the lateral direction of the door body **10**. A seal member **12** is made of an elastic material such as a rubber, and adheres on an outer peripheral portion **10***a* of the door body **10** in a frame shape or circularly. Plural notches **10***b* (recess portions) are formed on the outer peripheral portion **10***a* and are arranged in an outer peripheral direction, to strengthen adhesion by widening adhesion area. A width of each notch **10***b* is set to enhance adhesion strength between the outer peripheral portion **10***a* of the door body **10** and the seal member **12**. Herein, the method of forming and adhering of the seal member **12** onto the door body **10** is explained with reference to FIGS. **2**A and **2**B.

Specifically, the door body **10** having the notches **10***b* is inserted at a preset position into a mold **20**. Thereafter, an elastic rubber material is injected into the mold **20**, so that the seal member **12** can be formed integrally with the door body **10** around the outer peripheral portion **10***a* of the door body **10**. In this mold **20**, a plurality of runners **21** are arranged. The runners **21** form passages of a rubber material injected from each gate **21***a*. Outlets **21***b*, from which a rubber material flows out, are provided in the runners **21**. The outlets **21***b* are throttled in the runners **21** to increase a flow of the rubber material ejected to the notches **10***b*. Thus, as shown in FIG. **2**B, the rubber material injected from the gate **21***a* is led to the notches **10***b* as shown b-**1** and b-**2** in FIG. **2**B, and is ejected from the outlets **21***b* of the runners **21**. Accordingly, as shown by b-**3** in FIG. **2**B, the seal member **12** is formed around the outer peripheral portion **10***a* like a frame.

As described above, the temperature of the injection material is raised by searing heat because the flow speed of the rubber material is increased around the notches **10***b*. Thus, adhesion strength is enhanced at the notches **10***b* particularly, in the outer peripheral portion **10***a* after the molding. In the first embodiment, the width of the notches **10***b* is set to be equal or less than the width of outlets **21***b* of runners **21**. In the first embodiment, because the rubber material effectively flows in the molding, it can prevent the seal member **12** from deformed, and from causing of a flash.

On the other hand, referring to FIG. **3**, a sealing surface **13***a*, having an inclined surface, is formed to protrude from an inner wall of a case **13**, which forms an air passage. An outer peripheral portion **12***a* of the seal member **12** of the butterfly door **1** press-contacts the sealing surface **13***a*, so that the outer peripheral portion **12***a* of the door body **10** can seal against the case **13**. Thus, the air passage can be closed. As a material for forming the door body **10** of the butterfly door **1**, a resin material such as polypropylene, nylon and ABS is suitably used. A filler, glass fiber or the like, may be added into the resin material in order to reinforce the door body **10**. As a material for forming the seal member **12**, an elastic material such as rubber, silicone rubber and thermo plastic elastomer (TPE) is suitably used. Especially, TPE enables stabilizing of adhesion strength between door body **10** and the seal member **12**. The case **13** for forming the air passage may be made of the same resin material as that of the door body **10**.

Operation of the butterfly door **1**, which has above-mentioned structure, is described as followed. The butterfly door **1**, when closing the air passage, is shown in FIG. **3**. When the rotation shaft **11** is rotated by a predetermined angle in a counterclockwise direction from the position in FIG. **3**, the air passage is opened. Thereafter, when the rotation shaft **11** is rotated in a clockwise direction by the predetermined angle, the air passage is closed.

When the butterfly door **1** closes the air passage, that is, when the butterfly door **1** is press-fitted onto the sealing surface **13***a* of the case **13**, separation force works on the outer peripheral portion **10***a* in a shearing direction ("A" direction in FIG. **3**). In this embodiment, because the plural notches **10***b* are provided, adhesion area between the seal member **12** and the door body **10** can be increased. Thus, adhesion strength between the seal member **12** and the door body **10** is enhanced comparing with a case without the notches **10***b*.

According to the manufacturing method of the first embodiment, because the flow speed of the injected rubber material around the notches **10***b* is increased, temperature of the injected rubber material is increased by the shearing heat. The raise of temperature enables strengthening of adhesion around the notches **10***b*, that is, between the outer peripheral portion **10***a* and the seal member **12**.

Further, the rubber material flow speed is increased by setting the width of the notches **10***b* to be equal or less than the width of the outlets **21***b* of the runners **21**. Thus, stable adhesion strength between the outer peripheral portion **10***a* and the seal member **12** can be maintained by the injection molding. Furthermore, the seal member **12** can air-tightly seal the sealing surface **13***a* of the air passage, by forming the seal member **12** to surround the outer peripheral portion **10***a* of the door body **10**. Thus, when the butterfly door **1** is closed, the air passage is blockaded tightly.

A second embodiment of a switching door of an air passage switching system according to the present invention will be described with referent to FIG. **4**.

In the above-described first embodiment, the plural notches **10***b* are formed at the outer peripheral portion **10***a* of the door body **10** whereto the seal member **12** adhere, was explained. However, in the second embodiment, plural protrusions **10***c* are provided on the outer peripheral portion **10***a* to be integrated with the seal member **12**, so that adhesion area between the door body **10** and the seal member **12** is increased. Concretely, as shown in FIG. **4**, the plural protrusions **10***c* are formed at the outer peripheral portion **10***a* to be arranged in the outer peripheral direction. Thus, similarly to the first embodiment, the adhesion area between the door body **10** and the seal member **12** is widened, thereby increasing the adhesion strength therebetween. The seal member **12** can adhere to the door body **10** by following method or the like. That is, the seal member **12** made of a rubber material is inserted into a mold at a preset position in the mold, and thereafter, a resin material for forming the door body **10** is injected into the mold. Even in this case, the door body **10** and the seal member **12** can be tightly bonded.

A third embodiment of a switching door of an air passage switching system according to the present invention will be described with referent to FIG. **5**. In the above-described first embodiment, the plural notches **10***b* or the plural protrusions **10***c* are formed on the outer peripheral portion **10***a* of the door body **10**. However, in the third embodiment, as shown in FIG. **5**, the plural notches **10***b* and the plural protrusions **10***c* are alternately arranged on the outer peripheral portion **10***a* in the outer peripheral direction. Even in this case, the door body **10** and the seal member **12** can be tightly bonded. Thus, similarly to the first embodiment and second embodiment, the adhesion area between the door body **10** and the seal member **12** is widened, thereby increasing the adhesion strength therebetween.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted

that various changes and modifications will become apparent to those skilled in the art.

For example, in the above-described first through third embodiments, the present invention is applied to the butterfly door **1**. However, the present invention can be applied to a switching door **2** having a rotation shaft **11** that is positioned on one longitudinal side end of the door body **10** as shown in FIG. **6**. In this case, the switching door **2**, as shown in FIG. **7**, is supported rotatably in the case **13**, to seal the sealing surface **13***a* formed in the case **13**. The seal member **12**, which has approximately a U-shape (C-shape) in cross-section is adhered integrally onto the outer peripheral portion **10***a* of the door body **10**, whereon the rotation shaft **11** is not positioned. Even in this case, the switching door **2** has the plural notches **10***b*. On the outer peripheral portion **10***a* shown in FIG. **6**, the adhesion strength between the door body **10** and the seal member **12** can be increased, similarly to the above-described first embodiments.

In the above-described embodiments, the plural notches **10***b* and the plural protrusions **10***c* are formed in the longitudinal side end of the door body **10**. However, the notches **10***b* and the protrusions **10***c* can be provided at the lateral side end.

In the above-described embodiments, the plural notches **10***b* and the plural protrusions **10***c* are formed on the door body **10**. However, a single notch **10***b* or a single protrusion **10***c* can be provided on the outer peripheral portion **10***b*. Even in this case, the advantage described in the above-described embodiments can be obtained.

In the above-described embodiments, the air passage switching door **1**, **2** of the present invention is used for the mode door and the air mixture door. In addition to that, the door **1**, **2** of the present invention can be used for an inside/outside air switching door or the like. Furthermore, the present invention can be used for an air passage switching door for other purpose than the air conditioning system for a vehicle. In short, the present invention can be used for air passage switching doors having a structure in which a seal member **12**, adheres to an outer peripheral portion **10***a* of a door body **10** in a lip-shape.

In the switching door **2** shown in FIG. **6**, the plural protrusions **10***c* can be provided on the outer peripheral portion **10***a*, similarly to the above-described second embodiment. Further similarly to the above-described third embodiment, the notches **10***b* and the protrusions **10***c* can be arranged on the outer peripheral portion **10***a* alternatively in the peripheral direction.

Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A manufacturing method of an air passage switching door comprising:

forming a door body having a plurality of recess portions recessed from an outer peripheral portion of the door body; and

inserting the formed door body in a mold at a predetermined position, such that the recess portions in the mold to be overlapped with outlets of runners for supplying an injection material into the mold, wherein:

the outlets of the runners are throttled to increase a flow speed of the injection material and to increase a temperature of the injection material around the recess portions.

2. A manufacturing method according to claim **1**, wherein the recess portions are formed so that each width of the recess portions in an outer peripheral direction of the outer peripheral portion is equal to or less than each width of the outlets of the runners.

3. A manufacturing method according to claim **1**, further comprising:

injecting the injection material from the outlets of the runner while the outlets are overlapped with the recess portions, respectively, so that a seal member is formed to surround the outer peripheral portion of the door body.

4. A manufacturing method according to claim **3**, wherein,

in the injecting, the seal member adheres to the outer peripheral portion of the door body.

5. A manufacturing method according to claim **3**, wherein the seal member is a thermo-plastic elastomer.

6. A manufacturing method of an air passage switching door comprising:

forming a door body;

forming a plurality of recess portions recessed from an outer peripheral portion of the door body; and

inserting the door body with the recess portions in a mold at a predetermined position, such that the recess portions are positioned in the mold to be overlapped with outlets of runners for supplying an injection material into the mold, wherein:

the outlets of the runners are throttled to increase a flow speed of the injection material and to increase a temperature of the injection material around the recess portions.

7. A manufacturing method according to claim **6**, further comprising:

injecting the injection material from the outlets of the runner while the outlets are overlapped with the recess portions, respectively, so that a seal member is formed to surround the outer peripheral portion of the door body.

8. A manufacturing method according to claim **3**, wherein an outer peripheral edge of the seal member forms a stepless surface.

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